

Oct. 29, 1957

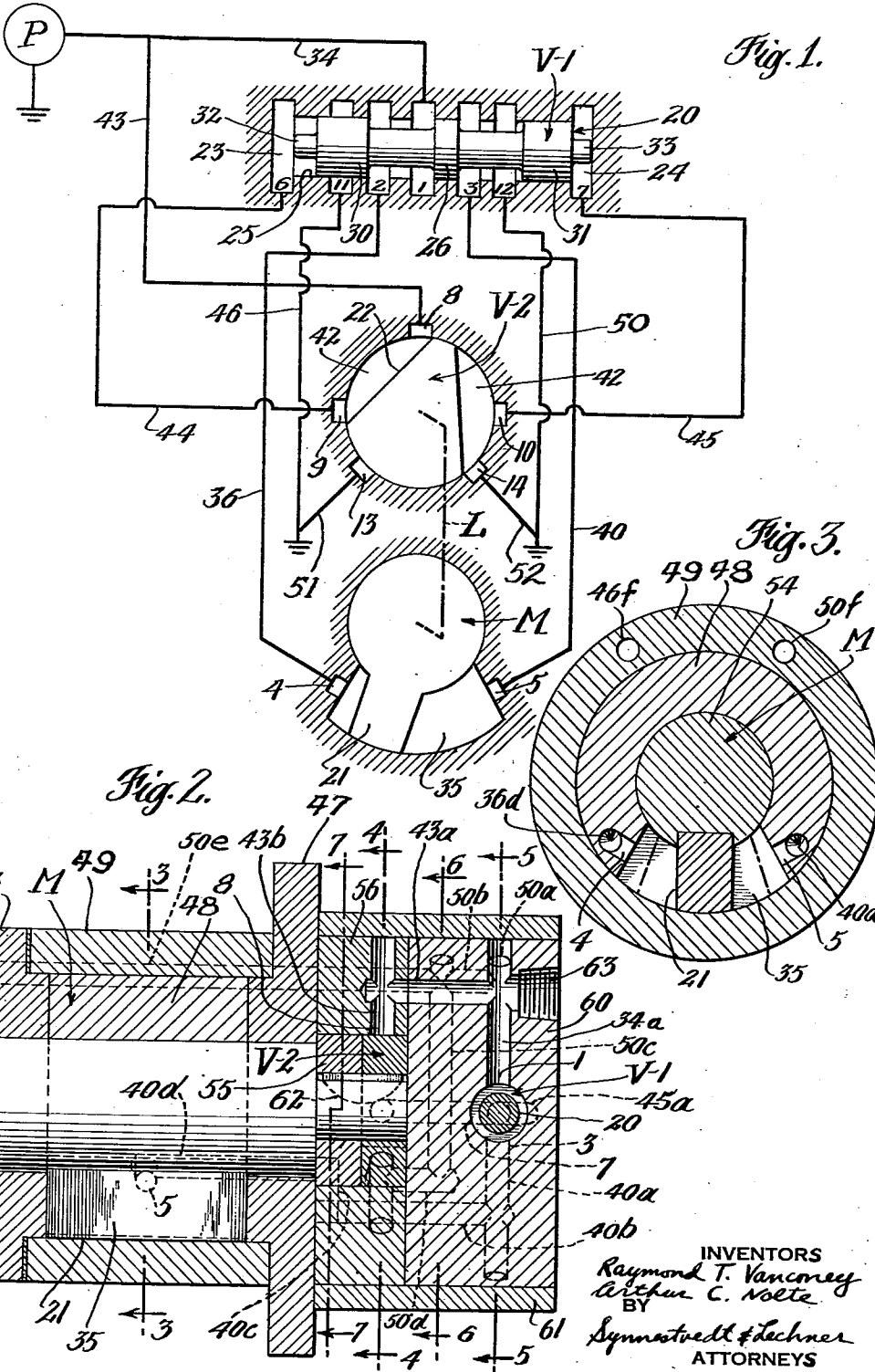
R. T. VAN CONEY ET AL

2,811,141

CONTROL MECHANISM

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2 Sheets-Sheet 1



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CONTROL MECHANISM

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2 Sheets-Sheet 2

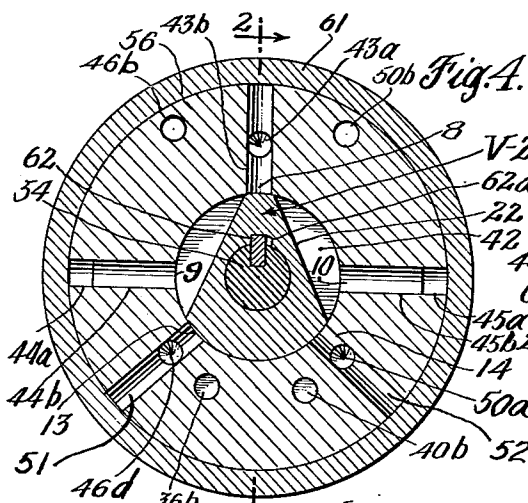


Fig. 4.

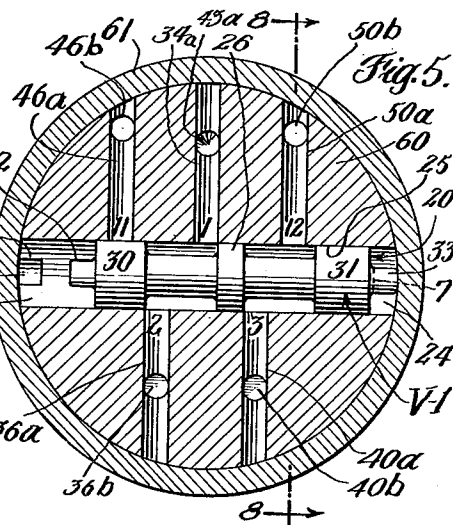


Fig. 5.

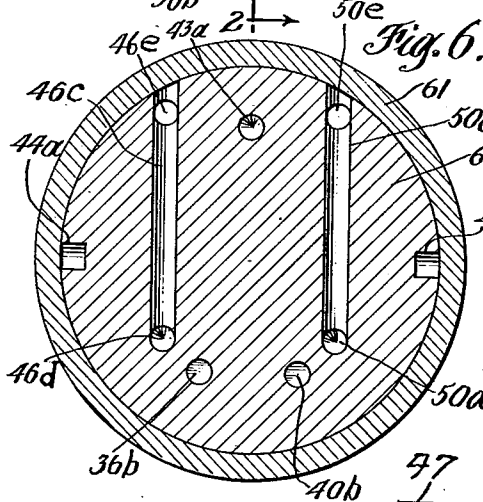


Fig. 6.

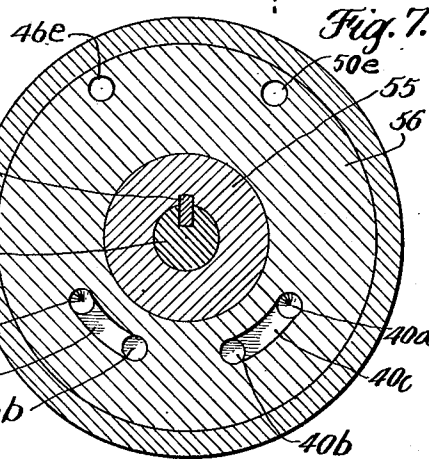


Fig. 7.

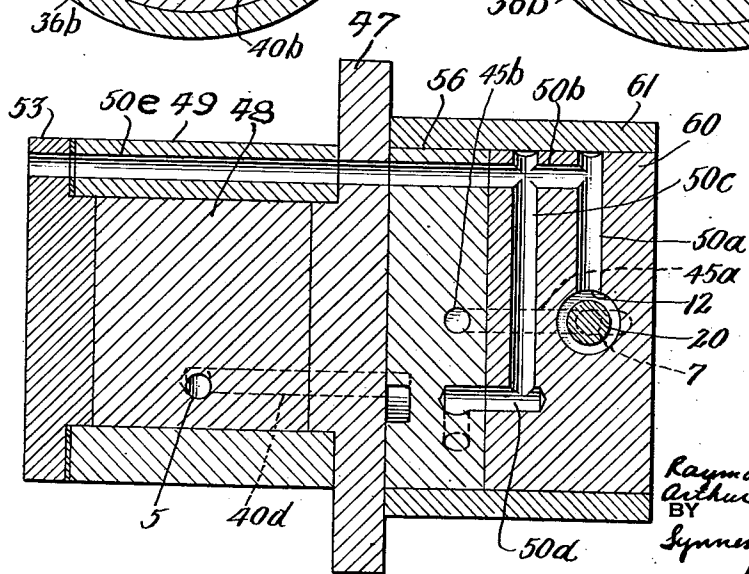


Fig. 8.

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CONTROL MECHANISM

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2 Claims. (Cl. 121-97)

This invention relates to fluid pressure equipment and, in particular, relates to a fluid-operated device having a motion-transmitting or thrust-producing member which is adapted to be continually oscillated.

While a wide variety of uses are contemplated, the invention has had particular application in promoting the quick and proper shifting of gears in a lathe headstock change-speed transmission. In this instance, the device is used to oscillate the work spindle shaft so that the gears to be intermeshed will slip together rather than engaging on their end faces.

One of the objects of the invention is to provide a fluid motor and a valve to supply fluid to the motor to cause the same to oscillate back and forth, together with means automatically operative when the motor has moved to a predetermined point in either of its directions to cause the valve to supply fluid in a manner to reverse the direction of the motor.

Another object of the invention is to provide a control device having a fluid motor and valve means to supply fluid to the same, together with means responsive to the operation of the motor to control the valve in a manner to continually reverse the motor.

Another object of the invention is to provide control means for a fluid motor including two valves—one to supply fluid to the motor and the other operated by the motor to supply fluid to the first whereby to control the operation thereof, and including a lost motion connection between the motor and the second valve.

Another object of the invention is to provide control means for continually reversing or oscillating a fluid motor, including mechanism to insure substantially constant torque when the motor is moving.

The foregoing objects, together with other objects and features of the invention, will be readily apparent from the following description and drawings wherein:

Figure 1 is a diagrammatic view illustrating several components of the device and the interconnections therebetween;

Figure 2 is a sectional elevational view illustrating the arrangement of parts in one embodiment of the invention, the section being taken as indicated by the lines 2-2 of Figure 4;

Figure 3 is a view taken along the lines 3-3 of Figure 2 and illustrating in particular one form of a fluid motor;

Figure 4 is a view taken along the lines 4-4 of Figure 2 and illustrating in particular one form of a valve incorporated in the preferred embodiment of the invention;

Figure 5 is a view taken along the lines 5-5 of Figure 2 and illustrating one form of a second valve incorporated in the preferred embodiment of the invention;

Figure 6 is a view taken along the lines 6-6 of Figure 2;

Figure 7 is a view taken along the lines 7-7 of Figure 2; and

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Figure 8 is a view taken along the lines 8-8 of Figure 5.

As shown diagrammatically in Figure 1, the invention contemplates a valve V-1, a valve V-2 and a fluid motor M. The valve V-1 is connected to a source of fluid pressure (called "working pressure" hereinafter) such as a pump P and has a spool 20 which is adapted to be moved to the left and right, and in doing so, supply working pressure alternatively to opposite sides of a vane 21 of the motor M so that the vane will oscillate back and forth. The vane 21 is connected, as indicated by the dotted lines L, to a movable or rotatable element 22 of the valve V-2, which is also connected to the pump P, and as the element 22 is moved back and forth, working pressure is supplied alternatively to the end chambers 23 and 24 of the valve V-1 to effect movement of the spool back and forth and thus control the flow of fluid to the motor M.

So long as pressure from the source P is maintained, the spool 20, the element 22 and the vane 21 will continue to move back and forth or oscillate. Thus, oscillatory motion can be obtained by making desired connections to take off motion from any of these elements. Preferably the element 22 and the vane 21 are connected to a common shaft and the mechanism which is to be oscillated is interconnected to the same.

Further details of the arrangement shown in Figure 1 follow.

The valve V-1 includes a bore 25, in which is mounted the spool 20. The spool has a center land 26 and two other lands 30 and 31 disposed on opposite sides thereof. The spool also has two abutments 32 and 33 which are arranged to abut the respective end walls of the bore 25 such as is shown for the abutment 33. A port 1 is open to the bore 25 and this port is connected to the pump P by the passage 34. On either side of the port 1 are ports 2 and 3 also open to the bore 25. For the position of the spool 20 as shown, the lands 26 and 30 cause the ports 1 and 2 to be in communication with one another.

It will be seen that the ports 6 and 7 are open to the end chambers 23 and 24 of the bore 25. It will be apparent that if the port 6 is connected to working pressure while port 7 is connected to drain, the spool will be moved to the position shown. However, if the port 7 is connected to working pressure and the port 6 connected to drain, the spool will be moved to the left (with the abutment 32 against the end wall of the bore 25).

The fluid motor M has a chamber 35 within which the vane 21 moves, and the ports 4 and 5 are open to the chamber on opposite sides of the vane. As is indicated, the ports 4 and 5 are connected by passages 36 and 40 to the ports 2 and 3 of the valve V-1. It will be apparent that if port 4 is connected to working pressure while the port 5 is connected to drain, the vane will move counter-clockwise, but if the port 5 is connected to working pressure while the port 4 is connected to drain, the vane will move clockwise.

The valve V-2 has a chamber 42 within which the element 22 moves and a port 8 is open to the chamber and also connected to the pump P by line 43. Ports 9 and 10 are open to the chamber 42 and are disposed on either side of the port 8 diametrically across from one another. The ports 9 and 10 are connected to ports 6 and 7 of the valve V-1 by passages 44 and 45. The element 22 is adapted to interconnect port 8 with ports 9 and 10 in a desired manner.

The supply of working pressure to either side of the motor vane 21 is controlled by the position of the spool 20 of the valve V-1 as explained following.

In the position of the spool as shown, working pressure from the pump P is in communication with the port 4 of the motor via passage 36, port 2, port 1 and passage 34. It will be apparent that if the spool were positioned so that the land 26 were between the ports 1 and 2, the working pressure from the pump would be in communication with the port 5 of the motor via the passage 40, port 3, port 1 and passage 34.

The supply of working pressure to either end of the spool 20 of the valve V-1 is controlled by the valve V-2 as explained following.

As mentioned heretofore, element 22 of the valve V-2 is connected to the vane 21 of the motor so that as the vane moves, the element moves with it. In the position of the element 22 as shown, working pressure is supplied to the port 6 of valve V-1 via the passage 43, port 8, chamber 42, port 9 and passage 44. If the element 22 of the valve V-2 is moved counter-clockwise so as to interconnect the ports 8 and 10, working pressure is supplied to the port 7 of valve V-1 via passage 43, port 8, chamber 42, port 10 and line 45.

The manner in which the various chambers and ports mentioned above are appropriately connected to drain is explained following.

In the valve V-1 the ports 11 and 12 are disposed on either side of the ports 2 and 3 and these are adapted to be covered and uncovered by the lands 30 and 31. These ports are connected to drain by the passages 46 and 50. In the position of the spool as shown, the port 11 is closed while the port 12 is in communication with port 3. Thus, the port 5 of the motor M is connected to drain via passage 40, port 3, port 12 and passage 50. If the spool is moved to the left, the land 31 covers the port 12 and the land 30 uncovers the port 11. Thus, the port 4 of the motor M is connected to drain via passage 36, port 2, port 11 and line 46.

The valve V-2 has ports 13 and 14 which are open to the chamber 42 and connected by the passages 51 and 52 to the drain passages 46 and 50. The movable element 22 is adapted to open and close these ports. In the position of the element 22 as shown, the port 10 and port 14 are in communication with one another. Thus, the end chamber 24 of the valve V-2 is connected to drain via port 7, passage 45, port 10, chamber 42, port 14 and passage 52. If the element 22 is moved so that the port 13 is open to port 9 (with the port 14 closed), the end chamber 23 of the valve V-1 will be connected to drain via port 6, passage 44, port 9, chamber 42, port 13 and passage 51.

The manner in which the device described above operates will be next explained. For purposes of description, all of the components of the device will be assumed to be in the position as shown in Figure 1 at the time the pump P is turned on.

The end chamber 23 of the valve V-1 is supplied with working pressure from passage 44, ports 8 and 9 of valve V-2 and passage 43, while the end chamber 24 is connected to drain via passage 45, ports 10 and 14 of valve V-2 and the passage 52. In the motor M, the right-hand side of chamber 35 is connected to drain via the passage 40, the ports 3 and 12 of valve V-1 and the passage 50, while the left-hand side of chamber 35 is supplied with working pressure via the passage 36, the ports 1 and 2 of valve V-1 and the passage 34.

The working pressure acting against the vane 21 starts to move the vane counter-clockwise. Since the element 22 and the vane 21 are interconnected, the element 22 also begins to move counter-clockwise. As the element 22 rotates, the ports 8 and 14 start to close off and as the element rotates past the port 8 to completely close off the connection between port 8 and port 9, the fluid from port 8 is transferred to port 10 so as to supply work-

ing pressure via passage 45 and port 7 to end chamber 24 of valve V-1. At the same time the port 13 is in communication with the port 9 and so the end chamber 23 of the valve V-1 is connected to drain via the passage 44, ports 9 and 13 and passage 51. The spool 20 is caused to move to the left and interconnect the ports 1 and 3 and consequently supply working pressure via the passage 40 and port 5 to the right-hand side of the chamber 35 of the motor M, the left-hand side of the chamber 35 being connected to drain through port 4, passage 36, ports 2 and 11 of the valve V-1 and passage 46. Thus, the vane 21 is caused to start to move clockwise and carry with it the element 22 of the valve V-2.

When the vane 21 and element 22 have rotated clockwise adjacent the position shown, the various fluid interconnections described above are made and the spool 20 is shifted to the right to again cause the motor M to reverse. This cycle of operation will continue so long as working pressure is supplied to the passages 34 and 43.

It will be apparent that the device described above has use in those applications where it is desired to move a mechanism with an oscillating motion. For example, the device has been used in change-speed transmissions of lathe headstocks to provide for quick and positive interengagement of gears. Ordinarily, a lathe headstock has a plurality of alternatively usable gear clusters adapted to be interconnected between the work spindle shaft and the main drive shaft for obtaining different speeds. Thus, the device in such installations may be used during the speed-changing operation to oscillate the work spindle so that the gear teeth will slip into mesh rather than engaging on their end faces.

One form of the invention as used in a lathe headstock transmission is shown in Figures 2 to 7. A description of this device follows, and numerals corresponding to those of Figure 1 will be used for similar parts.

As seen in Figure 2, the device on the left-hand side includes a generally cylindrically-shaped center piece 47, a motor body 48, a spacer 49, and a cap 53, which are all secured together by bolts (not shown). A shaft 54 is rotatably mounted in the cap 53, motor body 48 and center piece 47, and the shaft carries the motor vane 21. As will be more apparent hereinafter, the chamber 35 of the motor is formed by the center piece 47, the spacer 49, the cap 53 and the shaft 54. As viewed toward the right, the device includes a spacer 55 mounted on the shaft 54, a valve body 56 (for valve V-2), a valve body 60 (for valve V-1) and the sleeve 61. The two valve bodies and the sleeve are interconnected together and to the center piece 47 by bolts (not shown). The rotatable element 22 of the valve V-2 is keyed to the shaft 54 by key 62. The chamber 42 of the valve V-2 is formed by the spacer 55, valve body 56 and valve body 60. The valve body 60 is provided with the bore 25 which carries the slider 20.

Further details of the structure of the motor are shown in Figure 3 wherein it will be seen how the chamber 35 is formed by the shaft 54, the motor body 48, the spacer 49 and the cap 53. Also, it will be noted that the ports 4 and 5 are cut in the body 48 and are open to the chamber on opposite sides of the vane 21. The vane is secured to shaft 54 in the manner indicated.

Further structural details of the valve V-2 are shown in Figure 4 wherein it will be seen that the rotatable element 22 is keyed to the shaft 54 and is movable in the chamber 42. The ports 8 and 9, 10, 13 and 14 cut in the body 56 are open to the chamber 42.

The manner in which the valve V-1 is arranged is shown in Figure 5 wherein the same numerals as used in Figure 1 are used to indicate the various ports, etc.

The manner in which the various passages referred to above are formed in the device is set out below.

The passage 34 from the pump P to the valve V-1 is formed (see Figures 2 and 5) by a threaded aperture 63 and a vertical bore 34a in communication therewith. This

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bore is open to the bore 25 to form the port 1. The threaded aperture is adapted to be connected to the discharge side of the pump.

The formation of passage 43, which interconnects the pump with the valve V-2, is explained following. The passage 43 is comprised of communicating portions 43a and 43b. As seen in Figures 2 and 5, the portion 43a is made by an axially extending bore in the body 56, and the portion 43b is made by a vertically extending bore in the body 56. The bore forming the portion 43b is open to the chamber 42 to form the port 8.

The manner in which passages 36 and 40 interconnect the ports 2 and 3 of the valve V-1 with the ports 4 and 5 of the motor M will next be explained. The passage 36 is comprised of communicating portions 36a, 36b, 36c and 36d, while the passage 40 is comprised of communicating portions 40a, 40b, 40c and 40d. As seen in Figures 2 and 5, the portions 36a and 40a are formed by two vertically extending bores in the body 60 and these bores, which are open to the bore 25, form the ports 2 and 3. The portions 36b and 40b are formed by two axially extending bores in the body 60 and in the body 56. As best seen in Figure 7, the portions 36c and 40c are formed by two arcuate grooves in the body 56. The portions 36d and 40d are formed by two bores in the motor body 48, and as best seen in Figure 3, these portions 36d and 40d are in communication with the ports 4 and 5.

The manner in which the passages 44 and 45 interconnect the valves V-1 and V-2 will next be explained. The passage 44 is comprised of communicating portions 44a and 44b, while the passage 45 is comprised of communicating portions 45a and 45b. As best seen in Figures 4, 5 and 6, the portions 44a and 45a are formed by two axially extending slots in the valve body 60 and the valve body 56. These slots are open to the bore 25 (Figure 5) to form the ports 6 and 7. As best seen in Figure 4, the portions 44b and 45b are formed by two radially extending bores in the body 56 and these bores, being open to the chamber 42, form the ports 9 and 10.

The manner in which the passages 46, 50, 51 and 52 form the drainage system of the device will next be explained.

The passage 46 is comprised of communicating portions 46a, 46b, 46c, 46d and 46e, while the passage 50 is comprised of communicating portions 50a, 50b, 50c, 50d and 50e. As seen in Figure 5, the portions 46a and 50a are formed by two vertically extending bores in the body 60, and these bores, being open to the bore 25, form the ports 11 and 12. The portions 46b and 50b (Figures 2, 5 and 8) are formed by two short axially extending bores in the body 56. The portions 46c and 50c (Figures 2, 6 and 8) are formed by two vertically extending bores in the body 60. The portions 46d and 50d (Figures 2, 6 and 8) are formed by two axially extending bores in the body 60, and these are in communication with the passages 51 and 52 (Figure 4) formed by radially extending bores in the body 56. The bores forming the passages 51 and 52 are open to the chamber 42 to form the ports 13 and 14. The portions 46e and 50e communicating respectively with portions 46b-46c and 50b-50c (Figures 6, 2, 4, 7 and 3) are formed by axial bores extending through the body 60, the body 56, the center piece 47, the spacer 49 and the cap 53. As will be apparent, the drainage system vents to atmosphere or drain at the cap 53. However, the cap 53 may be provided with fittings so as to connect the drainage system directly to the intake side of the pump if that type of an arrangement is desired.

Referring back to the valve V-2 (Figure 4) and the motor M (Figure 3), it is pointed out that a lost motion connection is provided between the element 22 of the valve V-2 and vane 21 of the motor. This may take the form of a keyway 62a which is made larger than the key

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62 so that the vane rotates a slight amount before its motion is transmitted to the element 22. This arrangement makes the operation of the valve V-1 and the motor slightly out of phase. In other words, when the vane reaches one end of its oscillation, the valve V-2 fully shifts the spool before the vane reverses direction. If both the vane and the spool were moved at the same time, the ports in valve V-1 might not have fully uncovered, hence, full unit pressure would not be applied to initially move the vane. Thus, the driving torque of the motor would be reduced. By allowing some lost motion, the valve is able to be fully shifted and the above-mentioned difficulty will not arise.

We claim:

1. A fluid-operated control device comprising: a body; a valve including a first chamber in said body and a valve spool in said chamber and movable in opposite directions, the spool having a center land and two other lands disposed on opposite sides of the center land; a first port in said body connectible with a source of fluid pressure and open to said first chamber and being in operative relationship with said center land; second and third ports in said body open to said first chamber disposed on opposite sides of said first port and adapted alternatively to be interconnected to said first port by movement of said center land; a rotatable shaft mounted in said body; a fluid motor comprising a second chamber in said body and a vane connected to said shaft and movable in the second chamber; fourth and fifth ports in said body disposed on opposite ends of said second chamber for supplying fluid to opposite sides of said vane; passages in said body respectively interconnecting said second and fourth and said third and fifth ports; a second valve including a third chamber in said body and an element movable therein, the element being secured to said shaft; sixth and seventh ports in said body and open to said first chamber for supplying fluid pressure alternatively to opposite ends of said spool; an eighth port in said body connectible with a source of fluid pressure and open to said third chamber; ninth and tenth ports in said body disposed on opposite sides of said eighth port and open to said third chamber and adapted to be interconnected to said eighth port by the movement of said movable element; passages in said body respectively interconnecting said sixth and ninth and said seventh and tenth ports; eleventh and twelfth ports in said body disposed on opposite sides of said second and third ports and open to said first chamber and adapted respectively to be interconnected to said second and third ports by said two other lands; thirteenth and fourteenth ports in said body disposed adjacent said ninth and tenth ports and open to said third chamber and adapted to be respectively interconnected with the ninth and tenth ports by the movement of said element; and passages in said body respectively interconnecting said eleventh and thirteenth and said twelfth and fourteenth ports, the passages being adapted to be connected to drain.

2. In a control device, a substantially flat, cylindrically-shaped center piece; a cylindrically-shaped motor body mounted on one side of said center piece and having an arcuately-shaped recess formed therein; a first spacer mounted on said center piece and surrounding said motor body; an end cap secured to said spacer, the end cap, the first spacer and the center piece cooperating with said recess whereby to form a motor chamber; a disc-shaped valve body mounted on the other side of said center piece, the valve body being formed with a centrally disposed circular aperture; a cylindrically-shaped valve body mounted on said disc shaped valve body and cooperating with the circular aperture to form a pilot valve chamber, the second valve body being formed with a diametrically extending aperture forming a reversing valve chamber; a shaft extending through said end cap, said first spacer, said center piece and extending into said pilot valve chamber; a motor vane secured to said shaft and disposed in said motor chamber; a pilot valve element secured to said shaft and disposed in said pilot valve chamber; a

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reversing valve spool axially movably mounted in said reversing valve chamber; and a sleeve surrounding said first and second valve bodies and cooperating with the second valve body to close off the ends of said diametral aperture.

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